

We claim:

1. A projection optical system which projects an image of a first surface onto a second surface, comprising:

5                   a lens component formed of fluorite;  
                  a lens component formed of quartz;  
                  a first lens group including at least one  
lens component formed of fluorite and having a positive  
refractive power;  
10                   a second lens group arranged in an optical  
path between the first lens group and the second  
surface and having a negative refractive power; and  
                  a third lens group arranged in an optical  
path between the second lens group and the second  
surface and having a positive refractive power;  
                  wherein when the number of the lens  
components formed of quartz is Snum, the number of the  
lens components formed of fluorite is Cnum, and a  
numerical aperture of the second surface side of the  
20 projection optical system is NA, the following  
conditions are satisfied:

$$Snum > Cnum$$

$$NA > 0.75.$$

2. The projection optical system as set forth in  
claim 1, wherein at least one lens component among the  
lens components formed of fluorite in the first lens

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group has a positive refractive power.

3. The projection optical system as set forth in claim 2, wherein the third lens group has at least one lens component formed of fluorite.

5 4. The projection optical system as set forth in claim 3, wherein when the distance between the first surface and the second surface is  $L$ , the distance between the first surface and the lens surface of the first lens group closest to the second surface side is  $L_1$ , and the focal length of the second lens group is  $f_2$ , the following conditions are satisfied:

$$0.2 < L_1 / L < 0.5$$

$$0.03 < -f_2 / L < 0.10.$$

10 5. The projection optical system as set forth in claim 4, wherein the first lens group has at least one aspherical lens surface.

15 6. The projection optical system as set forth in claim 5, wherein the lens groups which form the projection optical system are the first, second and third lens groups only.

20 7. The projection optical system as set forth in claim 6, wherein the projection optical system is optimized with respect to light having a center wavelength of 200 nm or less.

25 8. The projection optical system as set forth in claim 2, wherein when the distance between the first

surface and the second surface is  $L$ , the distance between the first surface and the lens surface of the first lens group closest to the second surface side is  $L_1$ , and the focal length of the second lens group is  $f_2$ , the following conditions are satisfied:

$$0.2 < L_1 / L < 0.5$$

$$0.03 < -f_2 / L < 0.10.$$

9. The projection optical system as set forth in claim 2, wherein the first lens group has at least one aspherical lens surface.

10 10. The projection optical system as set forth in claim 2, wherein the lens groups which form the projection optical system are the first, second, and third lens groups only.

11. The projection optical system as set forth in claim 2, wherein the projection optical system is optimized with respect to light having a center wavelength of 200 nm or less.

12. The projection optical system as set forth in claim 1, wherein the third lens group has at least one lens component formed of fluorite.

20 13. The projection optical system as set forth in claim 1, wherein when the distance between the first surface and the second surface is  $L$ , the distance between the first surface and the lens surface of the first lens group closest to the second surface side is

L<sub>1</sub>, and the focal length of the second lens group is f<sub>2</sub>, the following conditions are satisfied:

$$0.2 < L_1 / L < 0.5$$

$$0.03 < -f_2 / L < 0.10.$$

5 14. The projection optical system as set forth in claim 1, wherein the first lens group has at least one aspherical lens surface.

10 15. The projection optical system as set forth in claim 1, wherein the lens groups which form the projection optical system are the first, second, and third lens groups only.

15 16. The projection optical system as set forth in claim 1, wherein the projection optical system is optimized with respect to light having a center wavelength of 200 nm or less.

20 17. A projection exposure apparatus which projects and exposes a reduced image of a pattern arranged in a projection negative plate onto a workpiece, comprising:

25 a light source having a center wavelength of 200 nm or less;

an illumination optical system which guides exposure light from the light source to the pattern on the projection negative plate; and

26 the projection optical system as set forth in claim 1;

wherein the projection negative plate can be arranged at the first surface, and the workpiece can be arranged at the second surface.

18. A projection exposure apparatus which projects and exposes a reduced image of a pattern arranged in a projection negative plate onto a workpiece, comprising:

a light source having a center wavelength of 200 nm or less;

10 an illumination optical system which guides exposure light from the light source to the pattern on the projection negative plate; and

15 the projection optical system as set forth in claim 2;

wherein the projection negative plate can be arranged at the first surface, and the workpiece can be arranged at the second surface.

19. A projection exposure method which projects and exposes a reduced image of a pattern arranged in a projection negative plate onto a workpiece, comprising the steps of:

20 supplying exposure light having a center wavelength of 200 nm or less;

guiding the exposure light to the pattern on the projection negative plate; and

25 projecting an image of the pattern on the

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projection negative plate arranged at the first surface onto the workpiece arranged at the second surface by using the projection optical system as set forth in claim 1.

5        20. A projection exposure method which projects and exposes a reduced image of a pattern arranged in a projection negative plate onto a workpiece, comprising the steps of:

10        supplying exposure light having a center wavelength of 200 nm or less;

15        guiding the exposure light to the pattern on the projection negative plate; and

20        projecting an image of the pattern on the projection negative plate arranged at the first surface onto the workpiece arranged at the second surface by using the projection optical system as set forth in claim 2.

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